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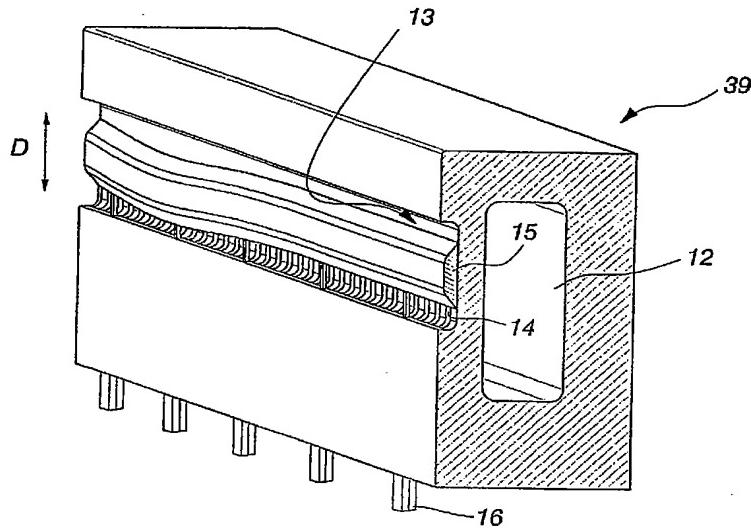
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(54) Title: METHOD FOR COATING A PAPER/BOARD WEB WITH A CURTAIN COATER APPARATUS



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(57) Abstract: The invention relates to a method of coating a paper/board web with a curtain coater, in which method the coating consists of at least two coating material layers. In the method, the total thickness and cross-profile of the coating are controlled by adjusting the thickness of at least one coating material layer, which provides or which together provide at least 40% of the total amount of coating, for determining the total amount of coating on a paper/board web (W), and that the determined amount of coating material is used as a basis for regulating the thickness of said at least one coating material layer as profiled in a cross-web direction for achieving a desired total thickness and cross-profile for the coating. The invention relates also to an arrangement for conducting the method.



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

Method for coating a paper/board web with a curtain coater apparatus

The present invention relates to a method of coating a paper/board web with a curtain coater; said method comprising the use of a nozzle beam, which is adapted

5 to have its length extending across a web to be coated and which comprises a nozzle unit, including at least two feed chambers extending lengthwise of the coater and supplied with a coating material by feed elements, and nozzle slots in flow communication with said feed chambers, which also extend lengthwise of the coater and have the coating material supplied from a respective feed chamber and

10 expelled further from an outlet opening of the nozzle slot, and said method comprising the use of a coating which consists of at least two coating material layers. The invention relates also to an arrangement for conducting the method.

The invention is aimed at providing an improvement in the control of a total thickness and in the regulability of a cross-profile in the coating layers of a curtain

15 coater intended for applying the coating paste of a paper/board web.

Curtain coaters can be specified as slot-fed and plane-fed coaters. The present invention is particularly directed to a plane-fed coater. It comprises feeding a coating material by means of a nozzle unit onto an inclined plane, along which it

20 flows towards a lip of the plane, resulting in a curtain as the coating is falling off the lip of the plane. The resulting curtain of coating material is controlled by means of an edge guide which is located, as suggested by its name, at the edge of a feeding lip.

25 A problem with prior art curtain coaters relates to controlling in various running conditions the cross-profile of a coating material for its application to a web being coated. There are no conventional means to provide an effective and active control over the coating profile.

30 It is prior known that the overall profile of a coating can be influenced in the designing stage of a coating beam as the shape of feed channels is decided. As the properties and/or feed rate of coating materials subsequently change, the changes have a clear impact on a cross-profile that cannot be corrected any more. Inaccuracies in manufacturing have a similar irreversible impact on the profile.

Regulation is also possible to provide a reasonably good cross-profile for a single layer by using an experimentally or mathematically predetermined by-pass rate. The term by-pass refers to that portion of a flow of coating material fed into a feed 5 chamber, which is returned from the other, downstream end of the feed chamber back to the supply or a storage bin. The purpose of a coating material by-pass is to ensure that a flow rate of coating material exceeding a given minimum rate be sustained in flow channels in a nozzle unit, also in its end facing the flow of coating material. The purpose of this is to avoid precipitation of a coating material and 10 build-up of deposits on the walls of flow channels. As the properties of a coating material change, this by-pass rate must be rectified by using correction factors. These provide compensation for errors resulting, for example, from variations in viscosity and dry content. However, accuracies of measurement and regulation can be at such a modest level that a desired profile cannot be obtained in a controlled 15 manner in all running conditions.

On the other hand, Finnish patent application FI 20035149 discloses an arrangement, which enables optimizing the cross-profile of a nozzle-discharged coating exactly for a particular grade of coating material and feed rate. In addition, 20 optimization can even be performed within a considerable range. Yet, when deviating from this optimized feed rate or when modifications are made to the properties of a coating material, the cross-profile becomes defective again.

In terms of the homogeneity and overall profile of a coating, the most serious 25 problem will nevertheless and above all be the fact that the coating of a paper/board web is often performed by using more than one layer of coating material. Each individual layer has its own specific cross-profile, which is in turn dependent e.g. on the overall feed rate of a coating material for this particular layer. In case of a multilayer coating process, a change in the feed rates of a 30 coating material is likely to develop a condition in which the cross-profiles of all layers are askew and even in the same direction and, thus, the overall profile of a coating no longer satisfies all requirements.

Thus, a combined result of these various above-described nuisance factors is that the overall profile of a coating may become even unacceptably poor. Accordingly, it is an objective of the present invention to provide an improved method of coating a paper/board web with a curtain coater, said method enabling the formation of a

5 consistent coating along the entire length of a nozzle unit crosswise of a web to be coated, as well as also the effective and quick regulability of various coating materials and feed rates while the run is in progress. In order to accomplish this objective, a method the invention is characterized in that the total thickness and cross-profile of a coating are controlled by adjusting the thickness of at least one

10 coating material layer, which provides or which together provide at least 40% of the total amount of coating, for determining the total amount of coating on a paper/board web, and that the determined amount of coating material is used as a basis for regulating the thickness of said at least one coating material layer as profiled in a cross-web direction for achieving a desired total thickness and cross-

15 profile for the coating. On the other hand, an arrangement of the invention is characterized in that the arrangement comprises measuring elements disposed in connection with a fibrous web for determining the total amount of coating from the paper/board web, and regulating elements for adjusting the thickness of at least one coating material layer, which provides or which together provide at least 40%

20 of the total amount of coating, as profiled in a cross-web direction for achieving a desired total thickness and cross-profile for the coating.

Hence, the invention is based on determining the total amount of coating from a web surface and on using the measuring results to effect a constriction of the

25 coating material flow between a feed chamber and a feed slot, and thereby on automating the regulation of a coating material flow rate, regarding at least one layer of coating material.

The thickness of a single layer of coating material can be adjusted locally in a cross-

30 web direction during a run to thereby achieve a desired regulation regarding the total thickness of a coating. In this context, the local nature of regulation is in reference to enabling an adjustment at desired intervals in a cross-web direction and especially regardless of other intervals. Thus, in other words, the adjustment of

a coating profile can be effected for each such interval to a desired value, regardless of other regions of the profile in a cross-web direction.

The basic objective in the method is to provide a cross-profile which is consistent.

- 5 What is essential is that regulation for the flow rate of a coating material be performed on the basis of a measured total coating thickness and especially on the basis of relative defects or cross-profile discrepancies detected therein. The measurement of a cross-coating profile can be performed for example by means of a measuring apparatus extending across the web. One essential benefit gained by
- 10 the invention is that the coating material type has no relevance to regulation and its accuracy.

Moreover, as the constriction of flow rate is performed particularly in relation to such a layer which constitutes at least half of the total amount of coating, even

- 15 minor relative modifications in the thickness of such regulated coating material layer shall be sufficient for rectifying the detected discrepancies in a total coating thickness. The adjustment of just a single layer of coating material shall be sufficient for providing a desired cross-coating profile at high accuracy.

- 20 Coating materials have always a more or less strong tendency to become absorbed in web structures, so the desired total coating thickness and cross-profile, cited as an objective of the inventive method, become quite evident as early as on the plane surface. The result in the actual web is thus a desired coating and web combination, in which the coating has desired properties, regarding especially its amount,
- 25 thickness and cross-profile.

Accordingly, the amount of coating material for regulated coating material layers is adapted to constitute preferably at least more than 40% of the total amount of coating applied to the web. The amount of coating as such is used in this context

- 30 particularly in reference to the dry content of a coating. As the coating material is being fed onto the plane surface of a nozzle beam prior to application, the coating material has a dry content which is typically lower than 70%. In the finished product, i.e. in a web emerging from a paper/board machine, the total amount of coating with respect to volume will be substantially smaller.

The amount of dry matter in layers regulated in the inventive method with respect to the amount of dry matter in the entire coating is preferably also more than half. It should be further emphasized that naturally the inventive method is by no means 5 limited to any particular dry matter contents in coating materials.

The volumetric amount of coating and, on the other hand, its applied thickness on top of the web at the moment of application correlate to each other in direct proportion. However, it should be noted in this respect that some of the coating is 10 generally absorbed into web structures after the application, so the thickness of a layer consisting only of coating mix on the surface of a web itself is in the finished product no longer equal to the total coating thickness defined by the total amount of coating. Thus, the coating materials and the web sort of integrate partially with each other.

15 On the other hand, when considering the situation on the plane surface of a nozzle beam prior to application, for example 50% of the total amount of coating represents in practice the corresponding portion of a total coating thickness as well, regarding the average thickness of a coating material layer across the entire width 20 of a web. Consequently, if the amount of coating material in a single coating material layer is for example half of the total amount of coating, the coating material layer shall have an average thickness which is also more or less half of the total thickness of coating. In the case of a single regulated coating material layer, for example, this single coating material layer also constitutes about half of the total 25 coating thickness.

Accordingly, even though the amount of coating material in a regulated coating material layer indeed constitutes, according to the invention, preferably more than 40% of the total amount of coating, the cross-coating profile may nevertheless 30 locally present spots in which the thickness of this regulated coating material layer falls short of this figure in terms of the overall coating thickness. Thus, errors appearing in the overall coating profile are rectified by regulating the thickness of this single layer in a cross-web direction, wherefor it is possible in the inventive method that, at some point of the cross-profile of a coating layer, its thickness has

been locally adjusted to a value which is lower than said figure of the total coating thickness. However, even in this case the coating material layer has a thickness which over most of the web width exceeds 40% of the total coating thickness.

- 5 Preferred embodiments of the invention are set forth in dependent claims 2-7. Regarding its details, features and advantages, the invention is illustrated more precisely in the following description of an exemplary embodiment and in the accompanying drawing, in which:
- 10 Fig. 1 shows, in a basically schematic, yet not to-scale view, an arrangement of the invention for coating a paper/board web, in which the feed rate of a coating material is in practice controlled by means of adjusting pin,
- 15 fig. 2 shows, in a schematic cross-sectional view, another plane-fed nozzle beam capable of being utilized in a method of the invention, in which the feed rate of a coating material for a middle layer is in practice controlled by means of a profiling member and adjusting pins,
- 20 fig. 3 shows cross-profiles for various coating layers and an overall coating in the case of a prior art manual regulation,
- fig. 4 shows cross-profiles for various coating layers and an overall coating as the coating thickness is regulated by means of a method of the invention.
- 25 In reference to fig. 1, there is basically shown an arrangement applying a method of the invention for coating a paper/board web. This embodiment of the invention makes use of an application beam 40, which is capable of forming a coating curtain 4 for its application to a web W. In the present embodiment, the application beam
- 30 40 is provided with three feed chambers 12, from which the coating material is delivered by way of equalizing chambers 13 and 13b to respective nozzle slots 30. The feed chamber 12 is optionally provided with by-pass routes (not shown) for a coating material by-pass.

Thus, in the present embodiment, the coating curtain 4 is made up of three individual coating material layers 1, 2 and 3 (fig. 1). The superimposed coating material layers 1, 2, 3, discharging from orifices 31 of the nozzle slots 30 and sliding along a top surface 35 of the nozzle beam, are guided over a feeding lip constituted by an edge 33 of the application beam in order to form the coating curtain 4.

- The amount of coating material, realized for both the base layer 1 and the top layer 3 and applied to the web W, is obtained as a difference between the total flow rate of coating material arriving at the nozzle beam 40 and the by-pass flow rate adjusted therefrom. A measurement for the feed rate of a coating material is provided for each individual layer of coating material. The measured flow rates are used as a basis for adjusting feed rates for the base layer 1 and the top layer 3 as desired.
- The overall cross-coating profile is controlled in practice by locally regulating the thickness of any individual layer of coating material. The regulation is preferably conducted across the entire width of a web. In this exemplary embodiment of the invention, it is the middle layer 2 of the three coating material layers which serves as a layer having its thickness subjected to local regulation. Naturally, instead of the middle layer, it is possible to conduct the regulation on any other one of the individual coating material layers. Likewise, the number of locally regulated layers can be more than one. What is essential regarding the choice of a regulated coating material layer or layers is that the relevant layer or layers to be regulated constitute together a sufficiently large portion of the total amount of coating and thereby also of the total thickness of coating. This makes it possible to provide a sufficiently accurate and effective control for the overall profile, even with just moderate local modifications to the thickness of regulated layers.

In this case, the total amount of coating for the regulated middle layer is discovered the same way as for other layers, i.e. it is calculable as a difference between the total feed rate and the by-pass rate of coating material for the discussed layer. The initial total amount of coating material can be set right on this basis. Local regulation for the thickness of a middle layer is conducted according to the amount of coating determined from the surface of a web W. Determination of the total

amount of coating on a web can be conducted here either by a direct measurement from the web surface or, for example, by determining it as a difference between the thickness of a web and the total thickness comprising a web and a coating.

- 5 The total thickness of coating can be measured from a web for example by means of a measuring apparatus 41 extending across the web. Deviations from a desired total thickness are thus found out. Measuring results presented by the measuring apparatus 41 are used as a basis for regulating the feed rate of a coating material for the middle layer 2 by means of a feedback provided from the measuring point to
- 10 the nozzle beam 40. The received measuring data is first transmitted to an automatic actuator 42. The actuator in turn operates elements 19, which are disposed in the nozzle beam 40 and which provide a further direct influence on the flow of a coating material.
- 15 Thus, a local fine adjustment for the thickness of a middle layer is in practice conducted by manipulating the flow of a coating material from the feed chamber 12 to the feed slot 30. In the embodiment of fig. 1, the flow is regulated by modifying the effective area of a flow channel between the feed chamber 12 and the feed slot 30. The adjustment of a feed rate is here conducted in the vicinity of an equalizing chamber 13 provided between the feed chamber 12 and the feed slot 30. The flow of a coating material is constricted in feed holes 18 provided between the feed chamber 12 and the equalizing chamber 13.
- 20
- 25 Each feed hole 18 is formed with a boring 19a, which opens to the exterior of a nozzle element and merges into a vertical section of the feed hole 18. The flow of a coating material is constricted by means of adjusting pin 19 functioning as control elements. Each regulating rod 19 is adapted for a lengthwise displacement into such boring 19a. Said adjusting pin are thereby operated directly by said actuator 42.
- 30 The regulating rod has its inner end 23, extending into the feed hole 18, preferably bevelled. The regulating rod 19 is sealed in the boring 19a by means of packings 22. The feed holes 18 have a mutual distance lengthwise of the nozzle element (hence normal to the viewing plane of fig. 1) of e.g. 50-600 mm, preferably 150-300 mm. Consequently, the thickness of a coating layer can be locally manipulated

at an accuracy which matches the spacing gaps between said feed holes.

Respectively, the total coating thickness is thus also adjustable at a substantially equal accuracy.

- 5 In the embodiment of fig. 2, which for the sake of clarity only depicts one nozzle element 39 of the nozzle beam assembly, the regulation of a coating material feed rate is in turn conducted by means of a profiling member 15, disposed in the equalizing chamber 13, and by regulating shanks 16 operating the same. Thus, in this embodiment, the actuator 42 is connected to these elements 15, 16.

10

The profiling member 15 is located on a surface of the equalizing chamber provided with the feed holes 14, extending over a distance defined by the successive feed holes. The effective area of flow channels can now be modified by adjusting the profiling member 15 in terms of its lateral position in the direction indicated by an

- 15 arrow D. By using the bar to manipulate the size of a feed hole, regarding either a single feed hole or a cluster of several feed holes, the flow rate of a coating material from the feed chamber 12 to the equalizing chamber 13 can be regulated locally in the longitudinal direction of the nozzle beam. The regulating shanks 16, functioning as regulating elements, have a mutual spacing lengthwise of the nozzle beam, i.e. in the direction of a cross-coating profile, which is e.g. 100-600 mm,
- 20 preferably 150-300 mm.

Having the middle layer subjected to a local adjustment, for example by utilizing nozzle beam structures and assemblies as depicted in figs. 1 and 2, makes it

- 25 possible to compensate for overall deviations from a desired coating thickness caused by other layers. Thus, the cross-coating profile can be given a desired shape and the overall coating thickness given a desired value. Accordingly, it is not an objective in a method of the invention to endeavour at a certain constant value in the thickness of a single coating material layer but, instead, to adjust its thickness
- 30 locally for obtaining a desired total coating thickness at a particular point in the cross-web direction. The coating layer to be locally regulated in terms of its thickness, hence in this case the middle layer, functions as a sort of control buffer whose thickness can be regarded as a range of regulation. Thus, the method enables in various running conditions and in an effective manner the achievement

of a desired overall coating profile regardless of whether or not the cross-profiles of individual coating material layers are in a correct setup.

According to one further concept of the invention, regulation can be enhanced by  
5 additionally using the regulation of a by-pass rate. Increasing or reducing the by-  
pass of a coating material can be used to adjust the cross-profile respectively in  
either way, and especially at an approximate level, and to perform a fine  
adjustment by means of automated constriction of the feed flow of a coating  
material. Thus, by using the by-pass as auxiliary regulation, it is possible to alleviate  
10 the need for regulating the flow rate between a feed chamber and a nozzle slot.

What is essential in a method of the invention is that a successful regulation is  
achieved by manipulating the thickness of just one coating material layer, and even  
in such a way that a successful regulation is achieved with just minor modifications  
15 to the thickness profile of a regulated layer. For example in a three-layer coating, as  
in the preceding exemplary embodiment, the amounts of coating on top and bottom  
layers are adapted to be small, typically at 2-4 g/m<sup>2</sup>. In this case, the middle layer,  
which functions as a regulated layer, is chosen to have a markedly higher thickness,  
typically at 8-15 g/m<sup>2</sup>. By virtue of this, even modifications of high percentage in  
20 top and bottom layers do not necessitate major compensating modifications in the  
middle layer for providing a desired overall coating profile. The amount of coating  
on the coating material layer or layers, functioning as a regulated layer, constitutes  
at least 40% of the total amount of coating on the coating material layers.  
Preferably, the amount of coating material on the regulated layers is 50%-80% of  
25 the total amount of coating. Respectively, if there is only one coating material layer  
to be regulated in terms of its thickness, the amount of coating material on the  
regulated layer is preferably the greatest with respect to the coating material layers  
of coating. The average thicknesses of layers with respect to the overall coating  
thickness are substantially in the same size category.

30

Figs. 3 and 4 visualise the operating principle of the method in reference to the  
cross-profiles of a manually regulated coating and that regulated by means of a  
method of the invention. As in the above exemplary embodiment, both cases are  
conducted by using three layers of coating material, the middle layer constituting

more than half of the total coating thickness. The thickness of coating material layers across the entire width is represented in the graphs as a percentage, the target value being 100. In the figures, the left side represents the end of a curtain coater at the feeding side and the right side in turn the end of a curtain coater at 5 the by-pass side on the other edge of a web.

Thus, in the case of fig. 3, the running conditions have changed from an optimized running mode and the profiles of both the bottom and the middle layer are askew to the right. Especially the bottom layer has a thickness which on the feed side of a 10 curtain coater, on the left in the figure, is more than, and on the right, on the by-pass side of a curtain coater, is considerably less than the desired thickness. In addition, the thickness of a top layer has become excessive on both edges of a web, and in the middle of the web, though accentuated to the right, the thickness has fallen short of the desired value. As a result of these defects, the total amount 15 of coating has fallen short of the target value at the right edge of a presently coated web, and at the left edge the coating has in turn gained excessive thickness.

In the case of fig. 4, the defects appearing in the cross-profiles of individual coating material layers are compensated for by regulating the thickness of a single layer 20 locally across the entire width of the web. In this case, it is the middle layer which is subjected to regulation. Because the middle layer makes up more than half of the total coating thickness, even minor percentage changes in the thickness of the middle layer will be sufficient for compensating for deviations in the overall profile caused by other layers. Thus, by increasing slightly the feed of a coating material 25 for the middle layer on the right side of the web and by respectively reducing it slightly on the left side, the profile defects of other layers can be readily compensated for. This results in a consistent summation profile and thereby a consistent cross-coating profile across the entire width of the web. Determination of the total amount of coating from the surface of a web or from a web can be 30 effected not only by a direct measurement of thickness but also, for example, by measuring first the thickness of just a web across the entire width of the web and by measuring, after the application of a coating, the overall thickness of the coating and the web again across the entire width of the web and by working out the local thickness of the coating as a difference between the measured thicknesses.

Instead of just thickness, the process of determining the amount of coating from a web can be preferably effected by using also other parameters. In addition, instead of performing determination immediately after application, the determination can

- 5 also be effected later, for example at some point of a coating drying process or from a finished end product.

It is also conceivable to adjust the thickness of a coating layer on the basis of the overall profile of a finished end product. In that case, in addition to or instead of the

- 10 desired overall profile of a coating, it is possible to work on the overall profile of web and coating as desired and, for example, to compensate for thickness variations in the actual web. Since the coating material is in most cases at least partially absorbed in web structures, the regulation of a coating material can be aimed at optimizing just this discussed overall profile of web and coating.
- 15 Determination of the combined coating and web thickness as well as merely the amount of coating can be carried out by means of prior known methods.

Thus, in the foregoing examples, the regulation of a coating material has only been focused on a single layer of coating material, but it is naturally also conceivable to

- 20 apply the regulation to more than just one layer. Measuring technology permitting, the design required for local regulation as discussed above can be provided, if necessary, even for all feed slots of a nozzle beam. This enables the profiling of all coating material layers independently of each other.

- 25 According to one further aspect of the invention, the use of actuators is possible not only for a cross-coating profile but also for the regulation of a machine-directed coating profile. The coating thickness can be regulated in a desired direction consistently over the entire cross-profile and, especially, concurrently while the run is in progress.

## Claims

1. A method of coating a paper/board web with a curtain coater, said method comprising the use of a nozzle beam, which is adapted to have its length extending across a web to be coated and which comprises a nozzle unit (1), including at least two feed chambers (12) extending lengthwise of the coater and supplied with a coating material by feed elements (4), and nozzle slots (30) in flow communication with said feed chambers, which also extend lengthwise of the coater and have the coating material supplied from a respective feed chamber and expelled further from an outlet opening (31) of the nozzle slot (30), and said method comprising the use of a coating which consists of at least two coating material layers, **characterized** in that the total thickness and cross-profile of a coating are controlled by adjusting the thickness of at least one coating material layer, which provides or which together provide at least 40% of the total amount of coating, for determining the total amount of coating on a paper/board web (W), and that the determined amount of coating material is used as a basis for regulating the thickness of said at least one coating material layer as profiled in a cross-web direction for achieving a desired total thickness and cross-profile for the coating.
2. A method as set forth in claim 1, **characterized** in that the amount of coating in regulated coating material layers comprises 50%-80% of the total amount of coating.
3. A method as set forth in claim 1, **characterized** in that it further involves bypassing the feed of a coating material for regulating said at least one coating material layer (2).
4. A method as set forth in claim 1, in which the coating consists of at least three coating material layers, **characterized** in that the method comprises placing said at least one coating material layer (2) between two other coating material layers.
5. A method as set forth in claim 1, **characterized** in that a flow communication between said at least one feed chamber (12) and a nozzle slot (30) pertinent thereto is established in the method by means of holes (14; 18) provided in one of

the feed chamber walls, through which the coating material is passable to a nozzle slot, and that the nozzle unit is provided with elements (15, 16; 19) capable of adjusting an effective area of the feed holes (14; 18) for regulating a cross-coating profile.

5

6. A method as set forth in claim 5, **characterized** in that the method comprises using, between said at least one feed chamber (12) and a nozzle slot (30) pertinent thereto, at least one equalizing chamber (13) which also extends lengthwise (W) of the coater and the feed holes (14; 18) open into said equalizing chamber.

10

7. An arrangement in connection with a curtain coater for coating a paper/board web with a coating which consists of at least two coating material layers, said arrangement comprising a nozzle beam, which is adapted to have its length extending across a web to be coated and which comprises a nozzle unit (1),

15 including at least two feed chambers (12) extending lengthwise of the coater and supplied with a coating material by feed elements (4), and nozzle slots (30) in flow communication with said feed chambers, which also extend lengthwise of the coater and have the coating material supplied from a respective feed chamber and expelled further from an outlet opening (31) of the nozzle slot (30), **characterized**

20 in that the arrangement comprises measuring elements (41) disposed in connection with a fibrous web (W) for determining the total amount of coating from the paper/board web (W), and regulating elements for adjusting the thickness of at least one coating material layer, which provides or which together provide at least 40% of the total amount of coating, as profiled in a cross-web direction for

25 achieving a desired total thickness and cross-profile for the coating.

1 / 3

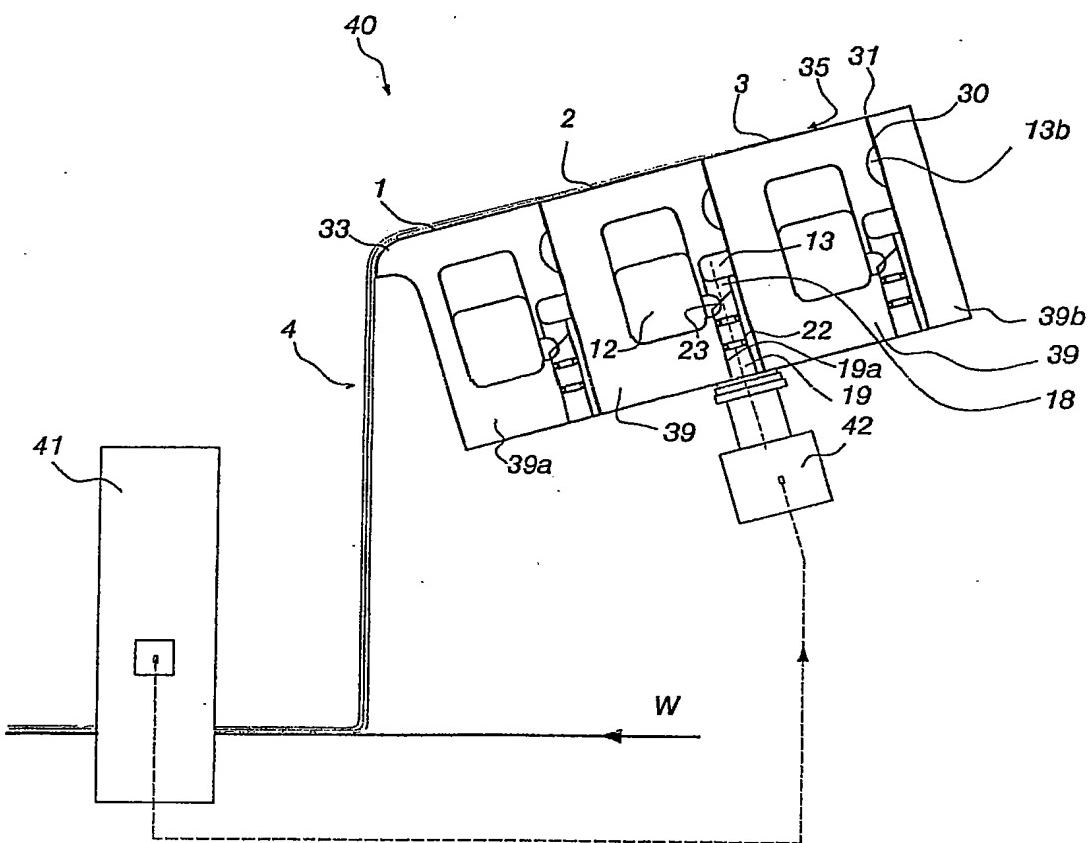
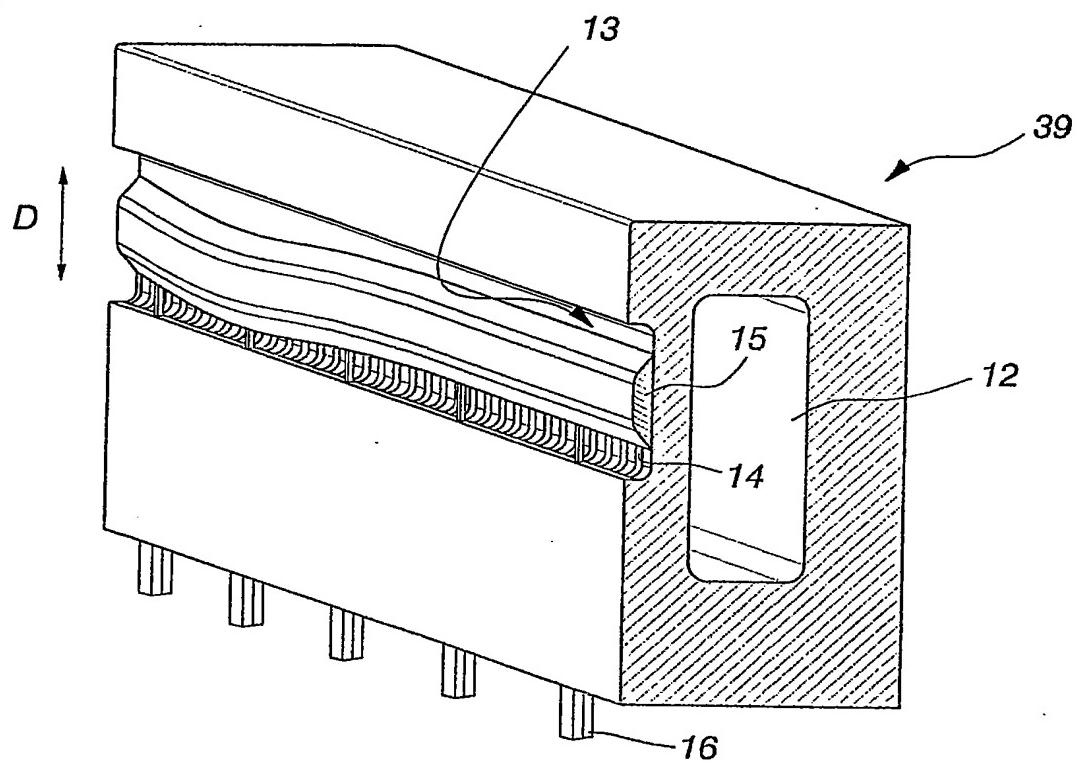


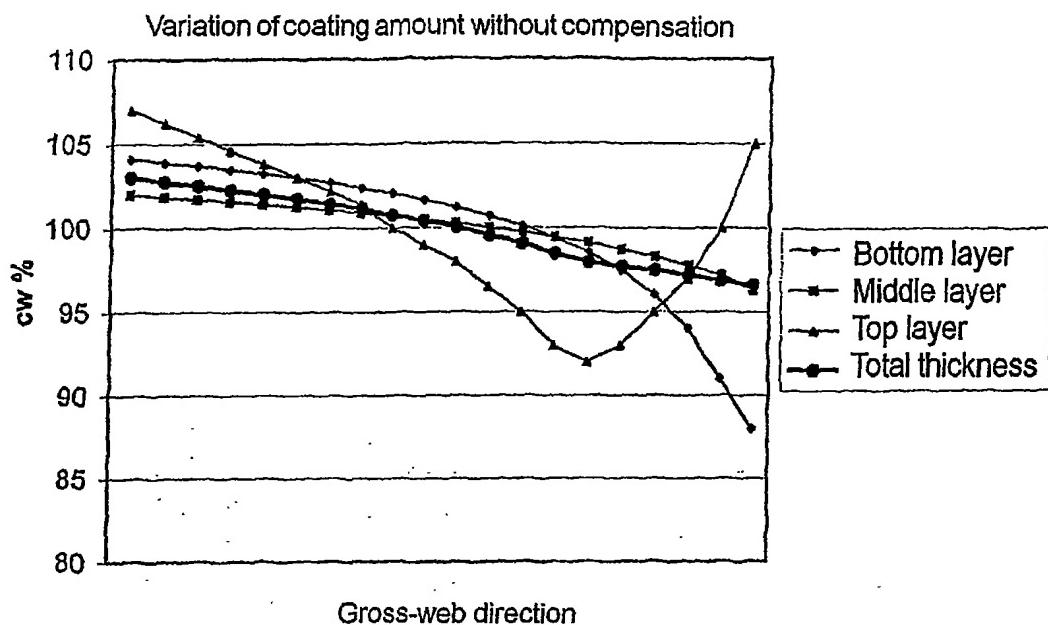
Fig. 1

2 / 3

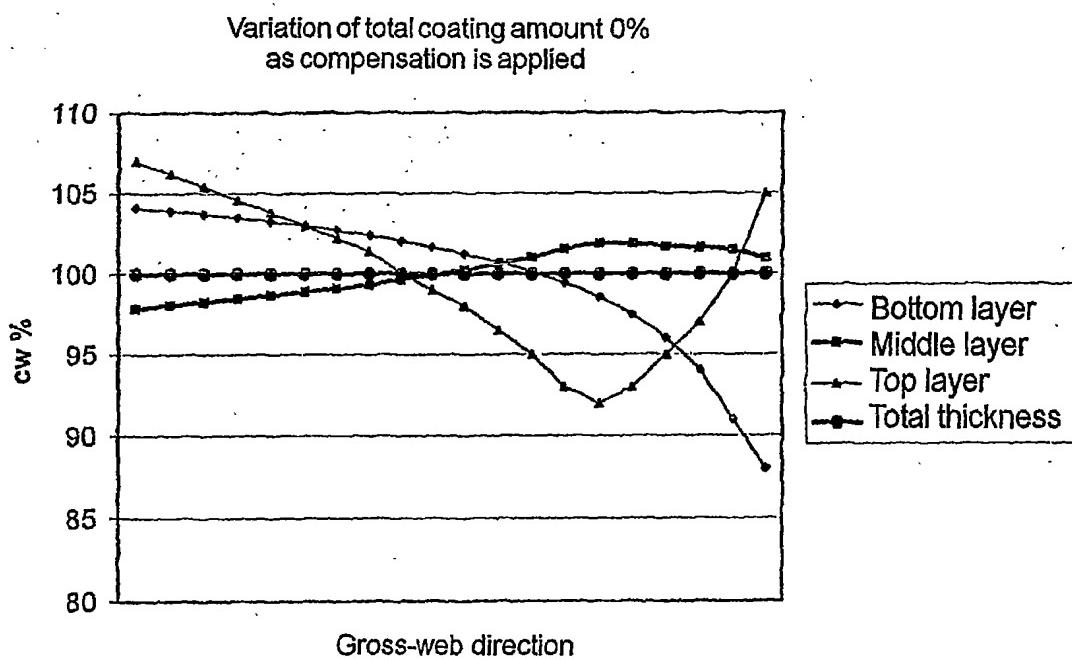


*Fig. 2*

3 / 3



*Fig. 3*



*Fig. 4*

## INTERNATIONAL SEARCH REPORT

International application No.

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## A. CLASSIFICATION OF SUBJECT MATTER

**IPC7: D21H 23/48, G05D 7/00**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC7: D21H**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**EPO-INTERNAL, WPI DATA, PAJ**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6248174 B1 (MARTIN KUSTERMANN), 19 June 2001 (19.06.2001)	1,4-7
A	---	2-3
Y	JP 09253554 A (MITSUBISHI PAPER MILLS LTD.), 30 Sept 1997 (30.09.1997)	1,4-7
A	---	2-3
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<input type="checkbox"/>	Further documents are listed in the continuation of Box C.	<input checked="" type="checkbox"/> See patent family annex.
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* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search	Date of mailing of the international search report
20 June 2005	22-06-2005
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer  Mats Raidla/MP Telephone No. + 46 8 782 25 00

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

28/05/2005

PCT/FI 2005/050052

US	6248174	B1	19/06/2001	DE	19803240	A	29/07/1999
				EP	0933674	A	04/08/1999
				JP	11262716	A	28/09/1999

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JP	09253554	A	30/09/1997	NONE
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